Creating a Pathway for the Biosynthesis of 1,2,4-Butanetriol

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1,2,4-Butanetriol trinitrate (BTTN) is manufactured by the nitration of 1,2,4-butanetriol (BT). The challenges associated with chemical synthesis of BT will be discussed along with the creation of a biosynthetic pathway that allows a single microbe to catalyze the conversion of D-xylose into D-BT. Central to this created pathway is the discovery of the ability of *Escherichia coli* to catabolize D-xylonic acid and the role that the enzyme D-xylonate dehydratase plays in this catabolism. The BT biosynthetic pathway was assembled in an *E. coli* host and begins with oxidation of D-xylose to D-xylonic acid. Xylonate dehydrogenase, which is heterologously expressed in an *E. coli* host from the *Caulobacter crescentus xdh* locus, is recruited for this purpose. Two xylonate dehydratases encoded by *xjhG* and *yagF* loci, which were discovered to be native to *E. coli*, catalyze the conversion of D-xylonic acid into 3-deoxy-D-*glycero*-pentulosonic acid. Decarboxylation of 3-deoxy-D-*glycero*-pentulosonic acid to form 3,4-dihydroxy-D-butanal is mediated by heterologously expressed *mdlC* isolated from *Pseudomonas putida*. Final reduction of 3,4-dihydroxy-D-butanal to BT is catalyzed by an alcohol dehydrogenase native to the BT synthesizing *E. coli*. BTTN is more stable than nitroglycerin and mixes effectively in a solvent-free process with nitrocellulose. These characteristics make BTTN an ideal replacement for nitroglycerin and a useful plasticizer in single-stage rocket motors.